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ABSTRACT

The animacy distinction is deeply rooted in the language faculty. A key example is differential object marking, the phenomenon where animate sentential objects receive specific marking. We used event-related potentials to examine the neural processing consequences of case-marking violations on animate and inanimate direct objects in Spanish. Inanimate objects with incorrect prepositional case marker 'a' ('al suelo') elicited a P600 effect compared to unmarked objects, consistent with previous literature. However, animate objects without the required prepositional case marker ('el obispo') only elicited an N400 effect compared to marked objects. This novel finding, an exclusive N400 modulation by a straightforward grammatical rule violation, does not follow from extant neurocognitive models of sentence processing, and mirrors unexpected "semantic P600" effects for thematically problematic sentences. These results may reflect animacy asymmetry in competition for argument prominence: following the article, thematic interpretation difficulties are elicited only by unexpectedly animate objects.

INTRODUCTION

Knowledge about animacy is an essential way in which human cognition carves up the world into natural kinds. It is not surprising then that animacy affects how people communicate about the world. Animacy expresses itself in some form or another in the majority of the world's languages (e.g., Dahl & Fraurud, 1996). In English, for example, animate entities are usually produced as subjects and in early sentence positions (e.g., Prat-Sala & Branigan, 2000), mirrored by processing costs for sentence-initial inanimate objects during comprehension (e.g., Weckerly & Kutas, 1999). Moreover, some languages realize animacy in their case system such that animate and inanimate noun phrases receive different case marking as sentential object ('differential object marking'; Bossong, 1989; see also Aissen, 2003; Malchukov, 2008). In the current study, we examine effects of differential object marking on online sentence comprehension using event-related potentials (ERPs).

An essential part of sentence comprehension is distinguishing the sentential arguments and interpreting their respective thematic roles (i.e., establishing 'who does what to whom'; see Bornkessel-Schlesewsky & Schlesewsky, 2009; Primus, 2011; Dowty, 1991). In many languages, especially those with relatively free word order, thematic interpretation is guided by a case system that marks the grammatical functions of arguments such as subject and object (e.g., Fillmore, 1968). Thematic interpretation in languages without an elaborate case system, however, is more strongly driven by argument prominence (Van Valin, 2005), which correlates with factors such as word order, animacy and definiteness. Animate, definite and first-mentioned entities are more prominent than inanimate, indefinite and later-mentioned entities. According to the distinctness principle (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2009; Lamers & De Hoop, 2005; Primus 2011), thematic role identification is facilitated when all arguments in a described event are as distinct as possible from one another in terms of all available dimensions of prominence. The sentence "John ate an apple" is canonical because it describes a definite, animate subject followed by an indefinite, inanimate object, whereas "The apple disgusted John" is atypical because it contains an animate object that is more agentive than the subject. Importantly, if sentential arguments resemble each other in one or more

dimensions of prominence, thematic role identification might be hampered, as may be observed in some form of processing cost.

This hypothesis has received support from ERP studies on the processing of animacy and case information during German sentence comprehension (e.g., Frisch & Schlesewsky, 2001, 2005). Frisch and Schlesewsky (2001) reported an N400 effect plus subsequent P600 effect for sentences with case conflict (two nominative case-marked arguments) when both arguments were animate, but only a P600 effect when the second argument was inanimate. The N400 results were taken to reflect problems with thematic integration that could be avoided or overcome by the use of knowledge that inanimate arguments are less agentive. Under the common interpretation that N400 modulations reflect the ease with which word-associated semantic knowledge is retrieved as a function of the context (Kutas, Van Petten & Kluender, 2006), these results suggest that syntactically-induced thematic problems carry a semantic processing cost along with a syntactic processing cost. This important novel idea, the N400 being sensitive to thematic interpretation (Frisch & Schlesewsky 2001), has subsequently received support from various linguistic manipulations in multiple languages (e.g., Frenzel, Schlesewsky and Bornkessel-Schlesewsky, 2011; Choudhary, Schlesewsky, Roehm & Bornkessel-Schlesewsky, 2009; Phillip, Bornkessel-Schlesewsky, Bisang & Schlesewsky, 2008). In contrast, the P600 results in both comparisons suggest more general processing consequences of two arguments competing for a single position, consistent with accounts of the P600 in terms of syntactic processing difficulty (e.g., Coulson, King & Kutas, 1998; Osterhout, Holcomb, Swinney, 1994) or perhaps reanalysis (e.g., Friederici, 1995; see also Kaan, Harris, Gibson & Holcomb, 2000).

The current study follows-up on these issues via differential object marking, a linguistic phenomenon whereby some direct objects receive morphological case marking while others remain unmarked. At least 300 languages of the world have differential object marking (e.g., Bossong, 1989). In Castilian Spanish, the language used here, animacy is among the most important features that controls object marking (e.g., Garcia Garcia, 2007): the differential object marker, the prepositional accusative (or, personal) 'a', is required for definite and specific direct objects when the object is animate but ungrammatical for inanimate objects (e.g., "Natxo escuchó a Agata/*a la canción": *Natxo listened to Agata/the song*). Differential object marking has been explained in terms of

prominence/markedness (e.g., Aissen, 2003; but see Garcia Garcia, 2007): because animate objects are less prototypical, and therefore more prominent direct objects, they are linguistically marked and receive case-marking, whereas economy dictates that case-marking should be omitted in other situations (see also Primus, 2011). Object marking thus makes thematic interpretation proceed more smoothly in face of atypical, agentive objects.

By means of ERPs, we investigated the processing consequences of correctly marked animate and inanimate direct objects, compared to incorrect ones (see Table 1). We compared ERPs elicited by animate nouns that missed the required object marking compared to those same animate nouns with object marking[1], and ERPs elicited by inanimate that had ungrammatical object marking compared to those same inanimate nouns that correctly received no marking. The obligatory nature of object marking for definite animate direct objects is well-established in the linguistics literature (e.g., Torrego, 1998) and a standard topic in canonical textbooks on Spanish grammar (e.g., Zagona, 2002).

A first prediction is thus that unmarked-animate and marked-inanimate both elicit P600 effects, reflecting increased syntactic processing cost (e.g., Osterhout et al., 1994), potentially due to case reanalysis (e.g., Friederici, 1995). A second prediction is that unmarked animate objects also elicit an N400 effect, signalling a thematic problem because object and subject are equally agentive, a marked situation normally heralded by case marking. Previous reports always included overtly ambiguous case marking on pre-verbal arguments (i.e., double nominative case marking) or sentences with inanimate subjects (e.g., Frenzel et al., 2011), while we used unambiguous and canonical SVO sentences with sentence-initial animate subjects, wherein it should be straightforward 'who does what to whom', but an incurred thematic processing difficulty might similarly play out in a semantic processing cost.

[1] To our knowledge, one ERP study that examined the equivalent of our animate-object sentences (Casado, Martín-Loeches, Muñoz & Fernández-Frías, 2005) reported a P600 effect for 'el' compared to 'al'. However, their participants explicitly judged which noun was sentential subject, and 'el' following a sentence-initial animate noun was predictive of an object-verb-subject (OVS) sentence structure. Despite the fact that such OVS sentences are in fact ungrammatical without any further context (see Demestre, 2012), the reported P600 effect was taken to index the reanalysis processes to compute the new phrase structure, as required by the task. Because the current experiment, however, does not involve such a task, and because we created a stimulus set such that 'el' or 'al' was never predictive of phrase structure, the Casado et al. results are not directly relevant to our current study.

In principle, presence of case marking on inanimate objects might create a similar case conflict. However, previous work suggests that animacy differences between subject and object facilitate hierarchization (inanimate arguments are less likely agents). This might thus preclude thematic processing difficulty, in which case we expect marked, inanimate objects only to elicit a P600 effect.

METHODS

Development and Pre-test of Materials

We created 120 Spanish sentence quadruplets that crossed object marking (marked/unmarked) with animacy (animate/inanimate) in a 2 by 2 design, using the template <animate subject noun> <transitive verb> <el/al> <animate/inanimate object noun> <at least two more words> ('al' is the contraction of 'el' and case marker 'a'). We refrained from using ditransitive verbs (after which 'al' can be dative case) and indefinite direct objects (which do not require marking). Animate/inanimate critical words were matched on several lexical variables, see Table 2, on relatedness to sentence context (indexed as semantic similarity values from latent semantic analysis), and on cloze value (as established in an independent sentence completion test on 16 participants). Additional results are listed from an independent plausibility pre-test on 22 participants, and from an additional grammaticality yes/no judgment test in which 20 participants judged 2 sentences per quadruplet (with conditions counterbalanced across lists).

Participants

Twenty right-handed students from the University of the Basque Country (10 males; average age = 21.4 years) gave written informed consent. All were native Spanish speakers, had no neurological or psychiatric disorders, nor participated in the pre-tests.

Procedure

Participants read sentences from a monitor, presented word-by-word (400 ms, 200 ms ISI), self-paced through button-press. There were 54 simple yes/no comprehension questions (half requiring a 'yes' button-press response) distributed across sentence types that probed information other than about the object noun. Using four lists, each sentence appeared in only one condition per list, but in all conditions equally often across lists.

Participants thus read 120 experimental sentences (30 per condition) mixed with 30 unproblematic fillers in break-separated sessions. Total time-on-task was 40 minutes.

Electroencephalogram Recording, Data Processing and Statistical Analysis

For details about the electroencephalogram recording, see Martin, Nieuwland and Carreiras (2012). After average-mastoid re-referencing and ICA ocular artifact correction, waveforms were automatically screened for artifacts (-150 ms to 850 ms after critical word onset). Four participants were excluded due to excessive artifacts (trial loss > 40 %). For the remaining 16 participants, average ERPs (baseline normalized) were computed over artifact-free trials per condition (average percentage = 95%, range = 95.2-95.6% across conditions).

First, using average amplitude per condition across all EEG electrodes a 2(object marking: correct, incorrect) × 2(animacy: animate, inanimate) repeated measures analysis of variance (ANOVA) was performed in the 100-300, 300-600 and 600-900 ms time windows after word onset. Additional analyses were performed to explore the scalp distribution of the observed effects and to reveal potential scalp distribution differences between observed effects in sentences with animate and inanimate objects. Electrodes were grouped into quadrants according to left/right of the midline and anterior/posterior to the crossline (excluding midline and crossline electrodes). For each time windows, a 2(object marking: correct, incorrect) × 2(animacy: animate, inanimate) × 2(anteriority: anterior, posterior) × 2(hemisphere: left, right) ANOVA was performed.

RESULTS

Critical words elicited in all conditions elicited the N1-P2-N400 complex as typically seen for visually presented words (see Figure 1), yet very distinct ERP effects were observed as a function of markedness (Figures 2 and 3 respectively): whereas unmarked-animate objects (e.g., ‘el obispo’) elicited an N400 effect compared to marked-animate objects (e.g., ‘al obispo’) starting at about 300 ms after word onset (Figure 2), marked-inanimate objects (e.g., ‘al suelo’) elicited a P600 effect compared to unmarked-inanimate objects (e.g., ‘el suelo’) that started already in the N400 time window (Figure 3).

No reliable effects were obtained in the 100-300 ms time window. In the 300-600 ms time window, there was a marginally significant object marking by animacy interaction effect ($F_{1,15} = 3.64$, $p < .1$) and a fully significant object marking by animacy by anteriority 3-way interaction effect ($F_{1,15} = 13.25$, $p < .005$). Follow-up of the latter effect revealed that the object marking by animacy interaction effect was only reliable at posterior electrodes ($F_{1,15} = 6.54$, $p < .05$). This interaction was driven by more negative ERPs for unmarked-animate objects compared to marked-animate objects ($F_{1,15} = 4.92$, $p < .05$, mean difference = 1.00 μV, *SE* = .45). In addition, while unmarked-animates and marked-inanimates did not elicit a robust different at posterior channels, the unmarked-inanimates did elicit a significantly larger N400 than the marked-animates ($F_{1,15} = 10.84$, $p < .01$, mean difference = 1.06 μV, *SE* = .32).

In the 600-900 ms time window, there was a significant object marking by animacy interaction effect ($F_{1,15} = 5.38$, $p < .05$) and a marginally significant object marking by animacy by anteriority 3-way interaction effect ($F_{1,15} = 3.43$, $p < .1$; this 3-way interaction effect was fully significant when midline electrodes were included, $F_{1,15} = 4.75$, $p < .05$), signalling again that the object marking by animacy interaction effect was most pronounced at posterior electrodes ($F_{1,15} = 6.51$, $p < .05$), while not reliable at anterior electrodes. At posterior electrodes, no reliable difference was found between marked-animate and unmarked-animate object, whereas marked-inanimate objects elicited more positive ERPs than unmarked-inanimate objects ($F_{1,15} = 5.43$, $p < .05$, mean difference = 1.45 μV, *SE* = .71).

We also examined brain responses to the presence or absence of object marking ('al' and 'el', respectively; the corresponding figure is in the supplementary materials). No statistically significant effects of object marking were found in any of the subsequent 100 ms time windows between 100 and 500 ms after article onset.

DISCUSSION

We used ERPs to examine the processing of case violations incurred by animate and inanimate direct objects in Spanish. Incorrectly case-marked inanimate objects (e.g., 'al suelo') elicited a central-posterior P600 effect compared to these same objects without marking. However, animate objects *without* required case marking (e.g., ' el

obispo') elicited an N400 effect compared to the same objects with case marking. No overall effect of animacy was observed (although correctly unmarked inanimate objects elicited a larger N400 than correctly marked animate objects), nor was there a reliable effect of markedness on preceding articles.

Whereas our prediction for the N400 was borne out by the data, absence of a subsequent P600 effect contrasts with earlier results (e.g., Frisch & Schlesewsky, 2001). In fact, this finding is unexpected given that these sentences are ungrammatical, and that ungrammatical sentences reliably elicit P600 effects (e.g., Osterhout, Kim & Kuperberg, 2012; Osterhout, McLaughlin, & Bersick, 1997, for review; although see Martin et al., 2012, for an exception). We discuss the N400 and P600 effects in turn.

Asymmetric N400 modulations for case violations

The N400 effect for animate object nouns without case-marked prepositions is consistent with earlier reported interactions between case and animacy (e.g., Frisch & Schlesewsky, 2001). These results beg the question why a thematic conflict plays out in the N400 component. N400 modulations are thought to index word-elicited retrieval from semantic memory, facilitated by contextually-guided predictions (for review, see Kutas et al., 2006), and modulated by relevance signals such as focus (e.g., Nieuwland, Ditman & Kuperberg, 2010; Schumacher & Baumann, 2010). Why does missing case-marking elicit an N400 effect?

We assume that animacy information associated with the case-marking is incorporated incrementally into the unfolding interpretation to allow a coarse-grained prediction about the upcoming object. Because the type of activity denoted by the verb may be different and have different consequences when directed at animate or inanimate objects (e.g., 'kissing', 'assaulting'), case marking can contribute distinctive meaning. However, an explanation in terms of prediction by itself does not explain the absence of N400 modulation for inanimate objects. If absent case marking is diagnostic of upcoming inanimateness, a similar N400 effect would be expected for case-marked inanimate objects. Perhaps the animacy hierarchy exerts its effects asymmetrically (see also Philipp et al., 2008; Paczynski & Kuperberg, 2011), such that object marking leads to a prediction of upcoming animacy but absence of marking does not lead to a prediction of upcoming inanimateness. If this were the case, however, one might have expected an ERP

modulation at the article as a function of markedness. If marked and unmarked articles both indeed lead to a coarse-grained prediction regarding animacy, perhaps only nouns that are more agentive or prominent than expected (i.e., animate when expecting inanimate) lead to a thematic problem. Conceptual information associated with animate object nouns may be more difficult to retrieve (as goes the common interpretation of N400 modulations) due to thematic conflict with the subject noun or due to a revised interpretation of the described event, or, alternatively, the unexpected animacy of the object could lead to deeper semantic processing (e.g., see also Paczynski & Kuperberg, 2011). In contrast, the inanimate object nouns are thematically less problematic but incorrect case marking is nevertheless detected.

It stands to argue, however, that the ungrammatical sentences that led to N400-P600 effects in previous work (e.g., Frisch & Schlesewsky, 2001, 2005) incurred more thematic ambiguity (due to double nominative case marking) than is likely here. In those studies, the two sentential arguments always preceded the verb such that thematic interpretation was independent of verb-semantics, and sentence position alone was insufficient to establish a thematic interpretation. In contrast, thematic roles in our Spanish SVO sentences with sentence-initial animate subjects are arguably straightforward, giving relatively little leeway for thematic competition. We therefore do not interpret the increased N400 for unmarked animate objects as indicating that these objects are considered for sentential subjects per se, but they are unexpectedly agentive nevertheless. It is possible that unmarked animate nouns require a revision of the described event from one where the inanimate undergoer itself does not participate in the event into one where both actor and undergoer participate.

Although our main interest lies in comparing effects of case-marking on animate and inanimate objects, it is interesting to note that correctly unmarked inanimate objects elicited a larger N400 than correctly marked animate objects, despite the matching of conditions on variables associated with N400 modulations. Our findings show an opposite pattern from that of Paczynski and Kuperberg (2011; see also 2012) who reported somewhat larger N400s for animate object nouns compared to inanimate object nouns. The materials and task used by Paczynski and Kuperberg differed from ours in several respects (aside from being in English). Their critical words were zero-cloze but more related to the sentence frames (higher SSVs) than our items were. Perhaps more importantly, their correct-

animate and correct-inanimate conditions differed in the main verb preceding the object-noun, which could have impacted the critical words differently. We do not have a good explanation for this discrepancy, but the current smaller N400 for animates might signal the overall higher accessibility of animate entities (e.g., Prat-Sala & Branigan, 2000). An alternative, tentative explanation can perhaps be sought in terms of semantic memory structure: animate entities have more semantic overlap (e.g., human, in almost all of our items) than inanimate entities have, so while our critical words had low cloze values overall, animate objects may have had more semantic overlap with the conceptual features as heralded by 'al'.

Absence of a P600 effect for grammatical case violations

The absence of a P600 effect for animate objects contrasts with P600 effects observed for case-induced thematic conflicts (e.g., Frisch and Schlesewky, 2001). Several differences between our study and previous work might help understand this discrepancy.

In our study, it was neglect of a grammatical rule (no case-marking for animate objects) gave rise to an N400 effect, whereas it was over-application of a rule (case-marking for inanimate objects) that gave rise to a P600 effect. This is essentially different from previous studies, which involved explicit thematic conflict from identical case-markings. Because the asymmetry of animacy and object marking are coextended, though, we cannot tease apart the differential impact of animate versus inanimate nouns and the differential impact of neglecting versus over-application of this particular grammatical rule (see also Choudhary et al., 2009).

Another difference is that our participants answered simple comprehension questions (which were unrelated to the critical manipulation), whereas participants in previous work (e.g., Frisch and Schlesewky, 2001, 2005; see also Frenzel et al., 2011) explicitly evaluated sentence well-formedness. Explicit judgment tasks might alter how participants process language as compared to without a secondary task, and, moreover, tend to elicit positive ERP components at critical-words even if responses are post-sentence (e.g., Roehm, Bornkessel-Schlesewsky, Rösler & Schlesewsky, 2007; see also Kuperberg, 2007). Due to summation of electrical signals at the scalp and potential spatio-temporal overlap of components, task-induced positive components can dampen or distort N400 activity,

whereas they can enhance (but also distort) P600 effects. Thus, whereas P600 activity in the current study cannot be ascribed to a secondary task, it is an open question whether and to what extent P600 effects reported for case conflicts in other studies can.

Finally, the absence of a P600 effect might be a function of the earlier semantic processing difficulties incurred by the unexpectedly animate objects. Because our language comprehension system has only limited processing capacity, participants' focus on re-establishing a coherent semantic interpretation may have diverted their attention from the 'smaller concern' of the syntactically problematic utterance (for a similar result, see Nieuwland & Van Berkum, 2008). This could be true especially in the absence of a grammaticality judgment task. The fact that marked inanimate objects did elicit a P600 effect suggests that participants were indeed sensitive to the ungrammatical nature of those sentences even in the absence of such a task. This P600 effect, indexing syntactic processing difficulty (Osterhout et al., 2012) or possibly reanalysis (e.g., Kaan et al., 2000), had a typical central-posterior scalp distribution as seen for other types of syntactic manipulations.

Implications for the electrophysiology of language

Of central importance to a neurobiological theory of language is an understanding of the mechanisms by which people apply the particular grammar of a language to produce and comprehend multi-word utterances (e.g., Bornkessel-Schlesewsky and Schlesewsky, 2009; Hagoort, Brown & Osterhout, 1999). The electrophysiological study of language aims to reveal how these processes unfold in real-time, by, for example, trying to map electrophysiological markers corresponding to specific sub-processes, and then using these markers to study how comprehension is affected modulated by the nature of the linguistic material and the context in which it is presented (e.g., Kutas et al., 2006; Osterhout et al., 1997; Osterhout & Nicol, 1999). Researchers in this field have long assumed that semantic processing and syntactic processing are reliably indexed by the N400 and P600 ERP component, respectively (e.g., Friederici, 1995; Hagoort, 2003). However, recent research has shown that semantic anomalies sometimes elicit P600 effects instead of N400 modulations (e.g., Bourguignon, Dury, Valois & Steinhauer, 2012; Hoeks, Stowe & Doedens, 2004; Kim & Osterhout, 2005; Kuperberg, Kreher, Sitnikova, Caplan, & Holcomb, 2007; Nieuwland & Van Berkum, 2005, 2008; Van Herten, Kolk & Chwilla, 2005; for review, see

Bornkessel-Schlesewsky and Schlesewsky, 2008; Brouwer, Fitz & Hoeks, 2011; Kuperberg, 2007). For example, the sentence "The hearty meal was devouring" is semantically anomalous because meals cannot devour, but this type of sentence elicits a P600 effect rather than the expected N400 effect (e.g., Kim & Osterhout, 2005). Such results suggest that participants consider this type of sentence as syntactically incorrect (i.e., the suffix '–ing' should be '-ed'), thematically reinterpreting the meal as patient rather than agent. These unexpected "semantic P600" effects can be said to be mirrored by the current observation that straightforward syntactic anomalies elicit only an N400 effect instead of the expected P600 effect. These results further chip away at a straightforward correlation between experimenter-defined levels of interpretation as being semantic or syntactic, and observation of N400 and P600 effects respectively.

Conclusions

We observed an N400 effect for incorrectly case-marked animate objects, but a P600 effect for incorrectly case-marked inanimate objects. These results testify to the potential importance of investigating the online processing correlates of interpretively-relevant grammatical rules (see also Choudhary et al., 2009). Moreover, our results support neurocognitive theories of sentence processing that can prioritize prominence, such that changes in prominence result in animacy processing asymmetries, even when these changes do not necessarily affect how people establish 'who does what to whom'.

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FIGURE CAPTIONS

Figure 1. Grand average ERPs elicited by critical words in each condition. Negative voltage is plotted upwards and waveforms are filtered (5 Hz high cut-off) for presentation purpose.

Figure 2. Grand average ERPs elicited by the (correctly) marked-animate and the (incorrectly) unmarked-animate object nouns, and scalp maps of the corresponding difference waves.

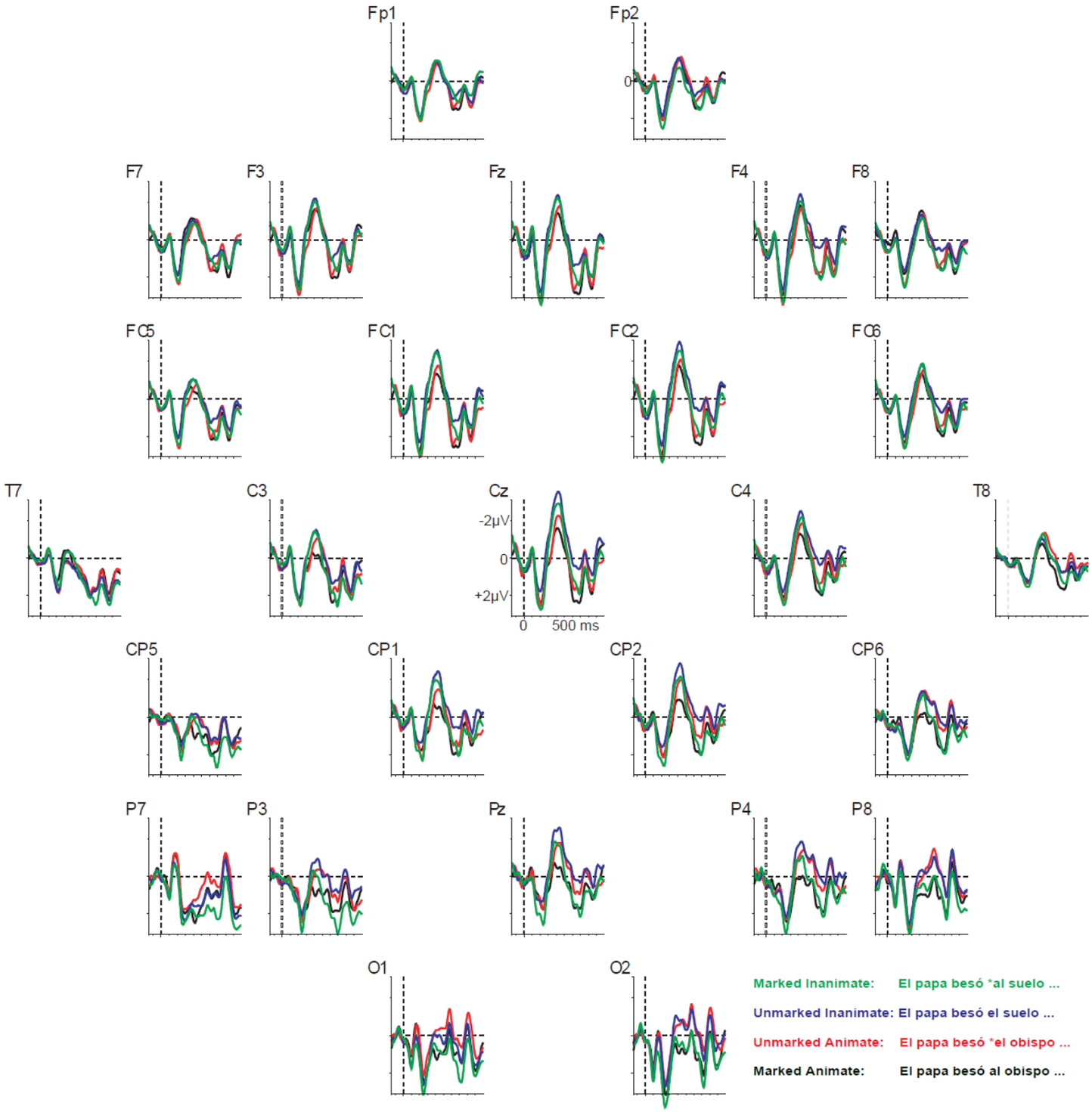
Figure 3. Grand average ERPs elicited by the (correctly) unmarked-inanimate and the (incorrectly) marked-inanimate object nouns.

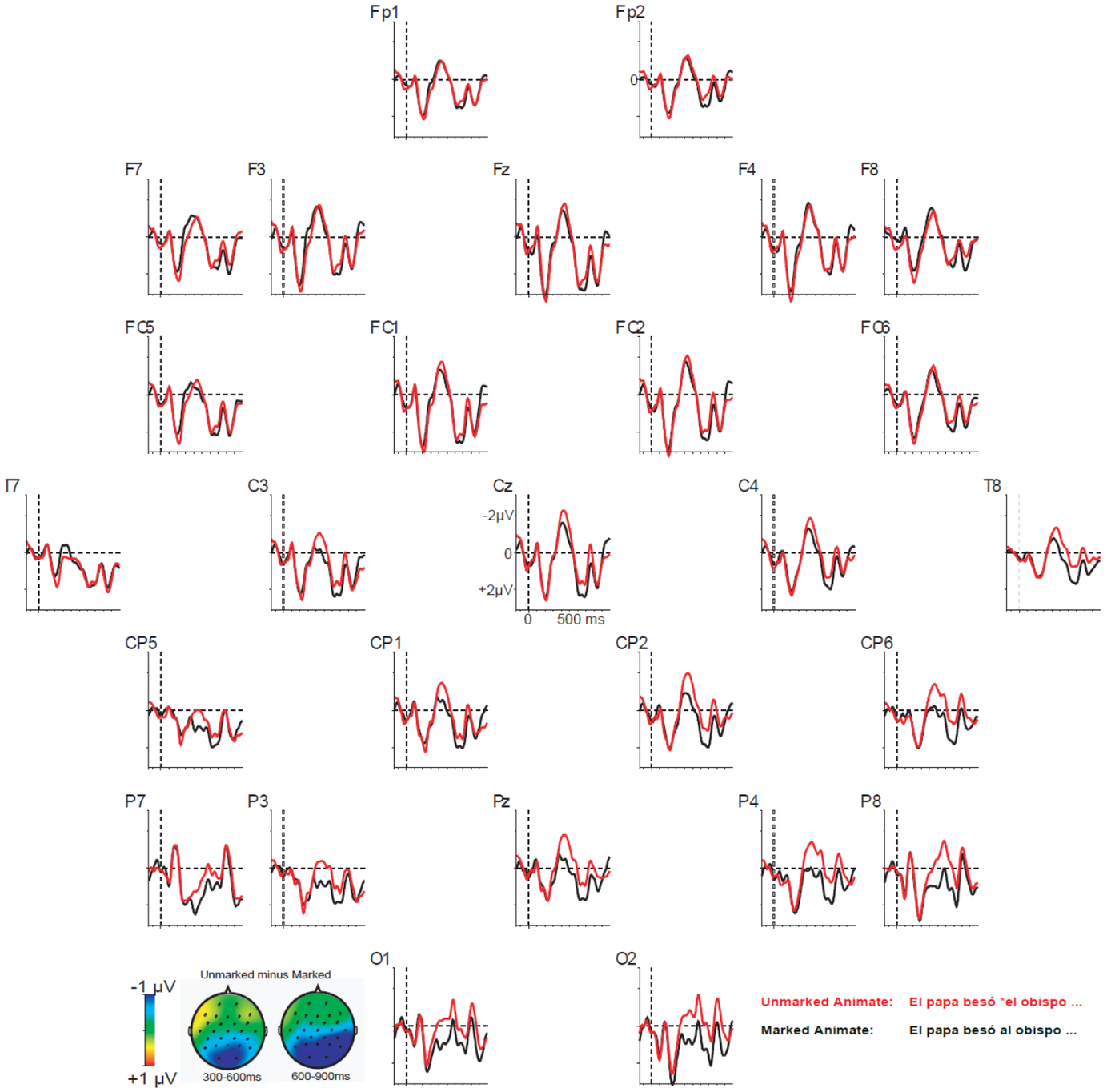
Table 1. Example sentences with marked/unmarked (al/el) animate/inanimate objects, and approximate translations	
El Papa besó al/el obispo/suelo en un gesto de bienvenida.	*The pope kissed the bishop/floor in a welcoming gesture.*
Los delincuentes asaltaron al/el chófer/vehículo por sorpresa.	*The thugs assaulted the driver/vehicle by surprise.*
El ciego golpeó al niño/chupete con el bastón.	*The blind person hit the kid/postbox with the stick.*
Note. Critical words are underlined for expository purposes only. Object marking is present on 'al' (contracted from the preposition accusative marker 'a' and the definite masculine article 'el') but not on 'el'.	

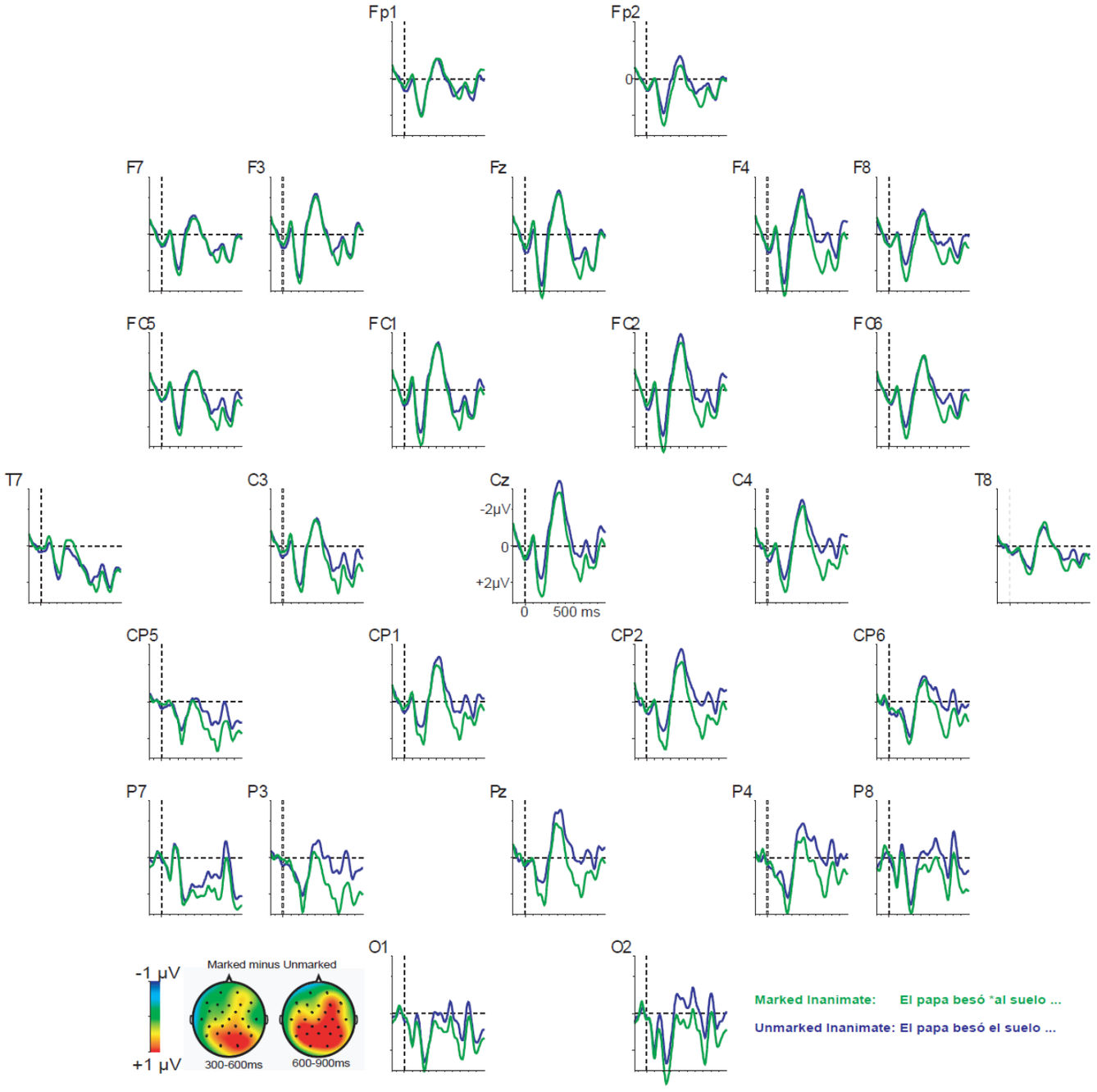
Table 2. Mean values for relevant lexical and sentential values

Condition	Length in letters	Log frequency	Familiarity	Imageability	Concreteness	Relatedness (LSA-SSV)	Cloze value (%)	Plausibility (1-7)	Grammaticality (after 'al/el', % correct)
Animate CW	6.3 (1.8)	1.31 (.64)	5.78 (.81)	5.58 (.72)	5.29 (.72)	.11 (.12)	8.9 (18.1)	4.80 (1.13)	93/89 (12/17)
Inanimate CW	7.1 (2.2)	1.28 (.63)	5.73 (.89)	5.60 (1.03)	5.21 (1.07)	.12 (.10)	6.3 (13.2)	4.87 (1.28)	92/94 (14/12)

Note. Standard deviations are given in parentheses. Log frequency, familiarity, imageability and concretess were generated from Davis and Perea (2005). LSA-SSVs are semantic similarity values from latent semantic analysis, obtained by cosine comparison of the critical word vector with the sentence vector (sum of all word-vectors in each sentence), using the Gallito 2.0 © software (http://www.elsemantico.com; Jorge-Botana, León, Olmos, & Hassan-Montero, 2010; Jorge-Botana, Olmos, & Barroso, 2013). Cloze value is the percentage of responses in which the animate/inanimate words were used to complete sentences truncated after al/el, respectively. We also computed percentage of animate/inanimate responses (following 'al' $M = 91/9$, $SD = 12/12$, following 'el' $M = 7/93$, $SD = 13/13$), and sentence constraint (highest cloze value from all responses per sentence; following 'al' $M = 35$, $SD = 18$, following 'el' $M = 36$, $SD = 20$). Plausibility scores (1-7 = implausible-plausible) are given for animate/inanimate words following 'al' and 'el', respectively. Grammaticality scores are the percentage correct responses from the grammaticality judgment rating: whereas marked-animate and unmarked-animate sentences received higher overall scores, no significant interaction between animacy and marking was obtained ($F < 1$).


Fp1
Fp2
F7
F3
Fz
F4
F8
FC5
FC1
FC2
FC6
T7
C3
Cz
C4
T8
-2µV
0
+2µV
0
500 ms
CP5
CP1
CP2
CP6
P7
P3
Pz
P4
P8
O1
O2
Marked Inanimate: El papa besó *al suelo ...
Unmarked Inanimate: El papa besó el suelo ...
Unmarked Animate: El papa besó *el obispo ...
Marked Animate: El papa besó al obispo ...


Fp1
Fp2
F7
F3
Fz
F4
F8
FC5
FC1
FC2
FC6
T7
C3
Cz
C4
T8
-2µV
0
+2µV
0
500 ms
CP5
CP1
CP2
CP6
P7
P3
Pz
P4
P8
O1
O2
Unmarked minus Marked
-1 µV
+1 µV
300-600ms
600-900ms
Unmarked Animate: El papa besó *el obispo ...
Marked Animate: El papa besó al obispo ...


Fp1
Fp2
F7
F3
Fz
F4
F8
FC5
FC1
FC2
FC6
T7
C3
Cz
C4
T8
-2µV
0
+2µV
0
500 ms
CP5
CP1
CP2
CP6
P7
P3
Pz
P4
P8
O1
O2
-1 µV
+1 µV
Marked minus Unmarked
300-600ms
600-900ms
Marked Inanimate: El papa besó *al suelo ...
Unmarked Inanimate: El papa besó el suelo ...